Point-by-point Reply to Comments from Reviewer 1

We greatly appreciate the reviewer's comments and suggestions. Below please find our reply (dark red).

Zhang et al. (2022) improved the EAMv1 by revising the sequence of nudging tendency in the model and increasing the nudging frequency. The manuscript has thoroughly discussed the nudging impacts from several sets of model simulations and provided suggestions for the nudged simulations. The manuscript is well organized and has addressed key issues in the nudged model simulations in EAMv1. Below are a few comments.

General comment

The EAMv1 nudging simulations are improved in this work. My major concern is the model resolution used in this work. The current model is configured to be 1 deg. It does not fully take advantage of reanalysis data with higher spatial resolution, which may dilute the impacts from ERAI and ERA5. On the other hand, if the model is configured to a higher spatial resolution (which is the direction in the global climate community), the model accuracy to simulation important small-scale processes could also be improved. In that case, it may require a different nudging strength or frequency.

For the current study, we focused on the analysis using the 1-deg model, because it's the standard resolution for v1 and v2 of E3SM (Golaz et al., 2019, Golaz et al., 2022) and is used for most model applications. But we agree with the reviewer that it would be useful to test the nudging implementation (e.g., relaxation time scale, frequency) at higher spatial resolutions (especially for 25km, which is close to the ERA5 resolution), so that we could maximize the benefit of using the high-resolution reanalysis data and improve the global atmospheric hindcast simulations.

We have made clarifications in the abstract and introduction to explicitly state that this study focuses on the E3SMv1 model that is configured with a 1-deg horizontal resolution.

References:

Golaz, J.-C., Caldwell, P. M., Van Roekel, L. P., Petersen, M. R., Tang, Q., Wolfe, J. D., et al. (2019). The DOE E3SM coupled model version 1: Overview and evaluation at standard resolution. Journal of Advances in Modeling Earth Systems, 11, 2089– 2129. https://doi.org/10.1029/2018MS001603

Golaz, J.-C., Van Roekel, Luke P., et al. (2022) The DOE E3SM Model Version 2: Overview of the physical model, Earth and Space Science Open Archive, doi: 10.1002/essoar.10511174.1. https://www.essoar.org/doi/10.1002/essoar.10511174.1

Specific comments:

Page 9, Figure 3, typo? No magenta box in Figure 4e. Maybe Figure 2e?

Yes. Corrected.

Page 21, line 350-351, there is no Table S3 in the Supplement.

There might be some technical issue. Table S3 in the original Supplement (https://gmd.copernicus.org/preprints/gmd-2022-10/gmd-2022-10-supplement.pdf) does show up on our computer. We will double-check it for the revised submission.

Also, I'm confused about the sign between line 351 and in Figure 12. Suggest to clarify the discussion here.

Figure 12 illustrates the ratio of the values derived from the nudged simulation to the values derived from the CLIM simulation. As the signs of aerosol-induced effects from the nudged simulation and CLIM are in the same sign, we will always have a positive ratio. We have made further clarifications in Figure 12 and Section 5 of the revised manuscript.

Page 21, line 365-369, this is also a typical approach in many other earth system models.

Yes, we agree. We slightly adjusted the wording in Section 5 of the revised manuscript and cited the previous studies on many other earth system models.